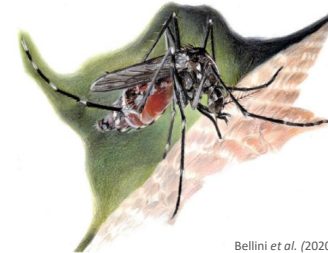


# URBAN POPULATION IN EUROPE IS INCREASINGLY EXPOSED TO VECTOR-BORNE DISEASES TRANSMITTED BY THE ASIAN-TIGER MOSQUITO

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Bellini et al. (2020)  
Fig. 1. Female Asian tiger mosquito during blood meal (drawing by Elisa Canaglia).



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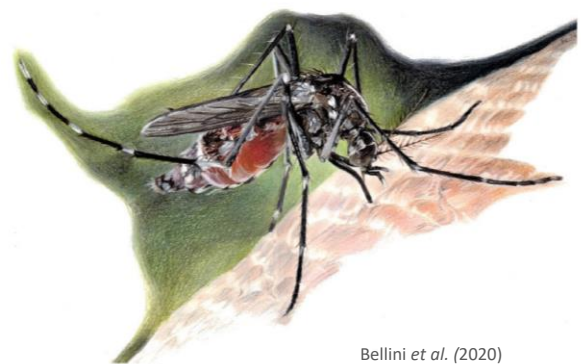
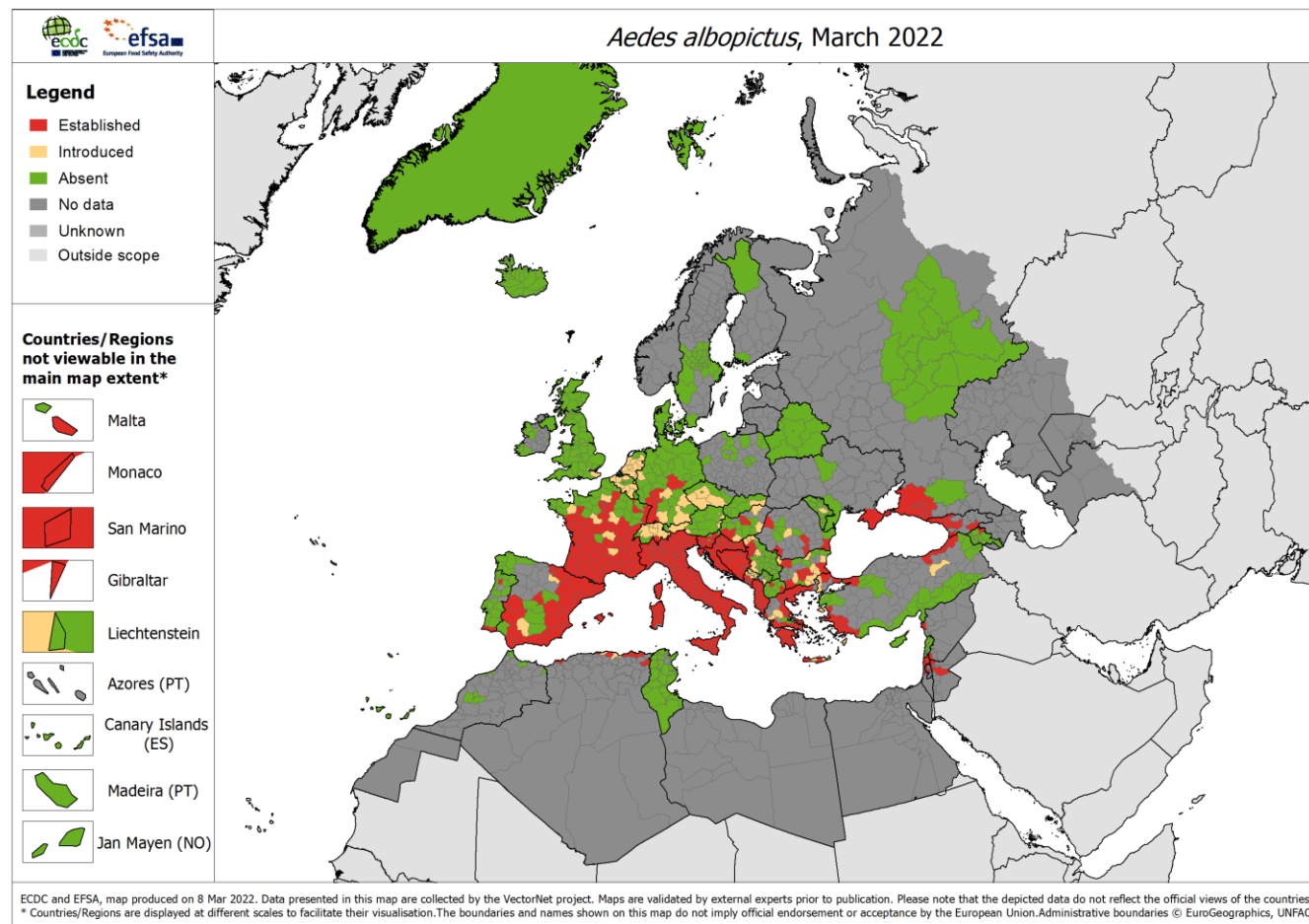
Bellini *et al.* (2020)

Fig. 1. Female Asian tiger mosquito during blood meal (drawing by Elisa Canaglia).

- Origin in Southeast Asia
- In Europe since 1979 (Albania), Italy in 1990
- Competent vector for dengue, Zika and Chikungunya
- Outbreaks in Croatia, France, and Italy in the last decade
- Increase in environmental suitability due to climate change

## Currently established in 30 European countries



## Urban areas are particularly vulnerable:

- supply of mosquito breeding sites in man-made water containers and through irrigation
- heat island effect, higher urban temperature amplifies climate change
- availability of potential hosts and dynamics of urban movements - increased risk of disease spread



1. Assess the environmental suitability for the establishment of the species in Europe
  - *Consensus between existing models*
2. Assess the suitability to the mosquito in large urban areas in Europe
  - *Present-day conditions and future climatic scenarios (2050)*
3. Estimate the urban population potentially exposed by 2050
  - *Present-day conditions and future climatic scenarios, with SSP scenario (2050)*

## 1. Environmental suitability in Europe

Data from existing models in Europe (7 present, 5 future)

Transform in binary scale (absence/presence)

Harmonize spatial resolution (25 km)

Identify common and divergent areas/patterns

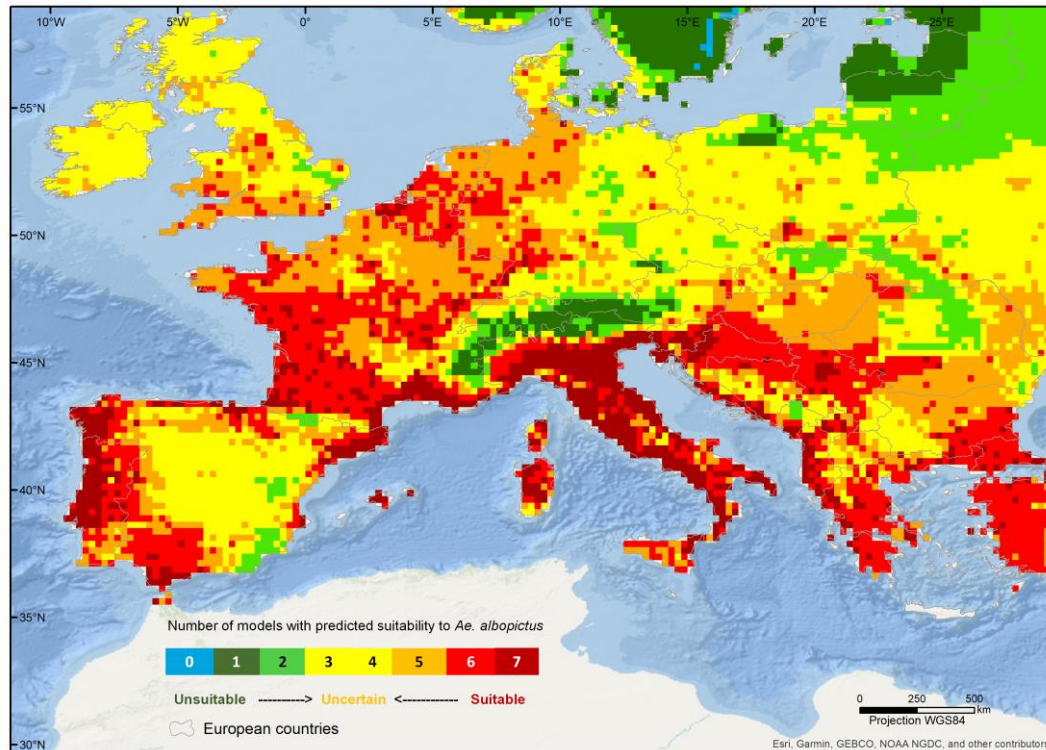
Classify consensus level and uncertainty

Identify future trajectories (2 timeframes)

References models	Geog. coverage	Spatial resolution	Present-day period	Future period	Scenario	Modelling technique
Caminade et al. (2012) <sup>19</sup>	Europe	0.25° ~ 25 km	1960–2009	2030–2050	SRES A1B	GIS-based (overwintering and seasonal activity); Multi-criteria decision analysis
Campbell et al. (2015) <sup>8</sup>	Global	0.16666° ~ 18 km	1950–2000	2041–2060	SRES B1	MaxEnt
Ding et al. (2018) <sup>11</sup>	Global	0.05° ~ 5 km	1970–2000			Support vector machine (SVM); Gradient boosting machine (GBM); random Forest (RF)
Kraemer et al. (2015) <sup>12</sup> , (2019) <sup>5</sup>	Global	0.04166° ~ 5 km	1960–2014	2050	RCP 6.0	Boosted regression trees (BRT)
Proestos et al. (2015) <sup>7</sup>	Global	0.46875° ~ 50 km	2000–2009	2045–2054	SRES A2	Fuzzy-logic
Rogers (2015) <sup>52</sup>	Global	0.5° ~ 55 km	1961–1990	2080 (estimated for 2050 by linear interpolation)	SRES B1	K-means clustering; Nonlinear discriminant analysis
Santos and Meneses, (2017) <sup>13</sup>	Global	30 arc-sec ~ 1 km	1950–2000			MaxEnt

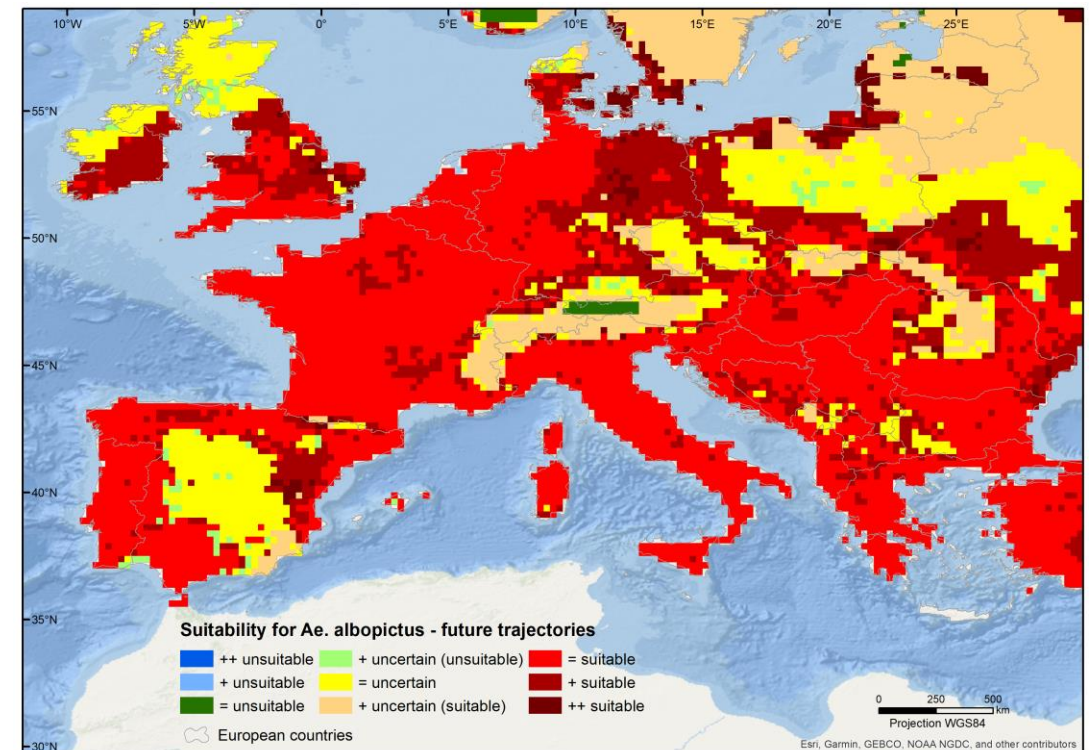
Categories	Present (7 models)	Future (5 models)
Unsuitable, low uncertainty	5 to 7 models agree unsuitable	4 to 5 models agree unsuitable
High uncertainty	Only 3 or 4 models agree	Only 2 or 3 models agree
Suitable, low uncertainty	5 to 7 models agree suitable	4 to 5 models agree suitable

## 1. Environmental suitability in Europe



### Present conditions

Areas of high uncertainty (high disagreement between models) mainly in eastern Europe, northern Britain, Ireland and central Spain.

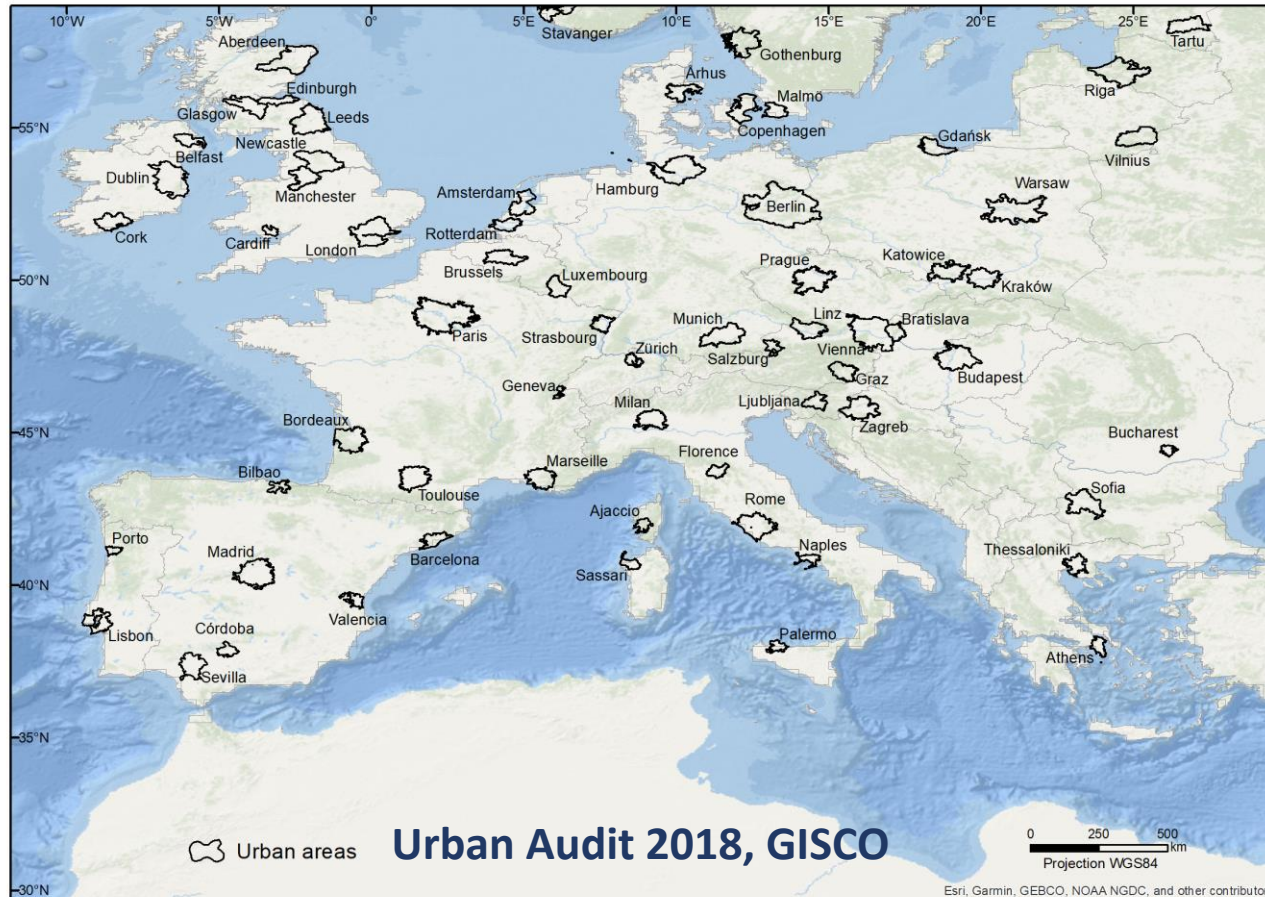


### Future trajectories

Suitable regions will encompass 21% more area, adding to the 47% of the continent that is suitable nowadays.

## 2. Suitability in European urban areas

**Functional urban area (FUA)** - a city and its commuting zone. A densely inhabited city and a less densely populated commuting zone whose labor market is highly integrated with the city (*OECD, 2012*).



### 62 metropolitan areas

- Large metropolitan (above 1.5 million people)
- Metropolitan (250.000 to 1.5 million people)

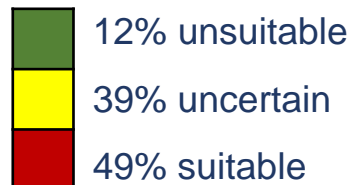
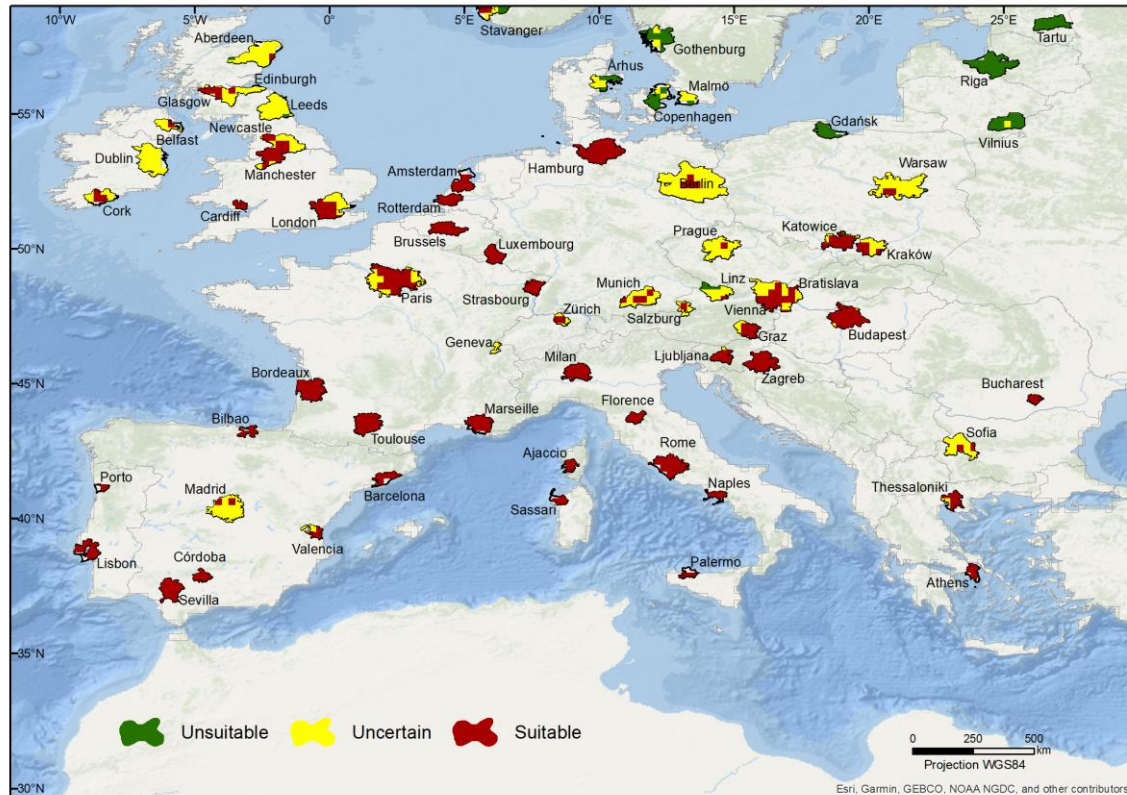
### 3 medium-size urban areas

- 3 medium areas (100.000 to 250.000 people), in Corsica, Sardinia and Estonia

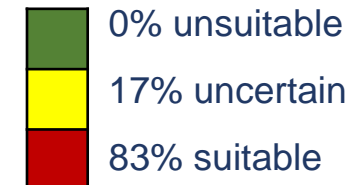
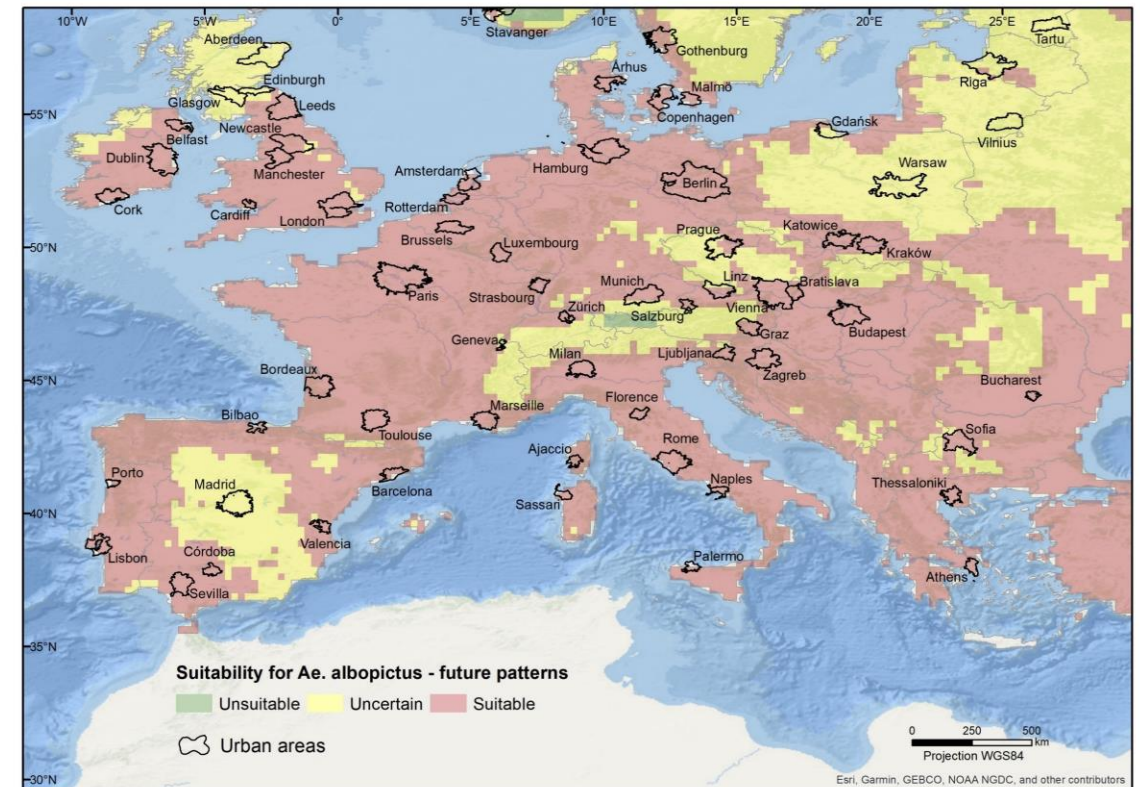
- Predominant class within FUA boundaries
- *Future worst-case scenario* – 1/3 urban area covered by a more unfavorable variation than given by the baseline

## 2. Suitability in European urban areas

### Present conditions



### Future conditions





## 2. Suitability in European urban areas

Main city (country)	P	F	Main city (country)	P	F	Main city (country)	P	F
Aberdeen (UK)	●	●	Glasgow (UK)	●	●	Prague (CZ)	●	●
Ajaccio (FR)	●	●	Gothenburg (SE)	●	●	Riga (LV)	●	●
Amsterdam (NL)	●	●	Graz (AT)	●	●	Rome (IT)	●	●
Århus (DK)	●	●	Hamburg (DE)	●	●	Rotterdam (NL)	●	●
Athens (EL)	●	●	Katowice (PL)	●	●	Salzburg (AT)	●	●
Barcelona (ES)	●	●	Kraków (PL)	●	●	Sassari (IT)	●	●
Belfast (UK)	●	●	Leeds (UK)	●	●	Sevilla (ES)	●	●
Berlin (DE)	●	●	Linz (AT)	●	●	Sofia (BG)	●	●
Bilbao (ES)	●	●	Lisbon (PT)	●	●	Stavanger (NO)	●	●
Bordeaux (FR)	●	●	Ljubljana (SI)	●	●	Strasbourg (FR)	●	●
Bratislava (SK)	●	●	London (UK)	●	●	Tartu (EE)	●	●
Brussels (BE)	●	●	Luxembourg (LU)	●	●	Thessaloniki (EL)	●	●
Bucharest (RO)	●	●	Madrid (ES)	●	●	Toulouse (FR)	●	●
Budapest (HU)	●	●	Malmö (SE)	●	●	Valencia (ES)	●	●
Cardiff (UK)	●	●	Manchester (UK)	●	●	Vienna (AT)	●	●
Copenhagen	●	●	Marseille (FR)	●	●	Vilnius (LT)	●	●
Cordoba (ES)	●	●	Milan (IT)	●	●	Warsaw (PL)	●	●
Cork (IE)	●	●	Munich (DE)	●	●	Zagreb (HR)	●	●
Dublin (IE)	●	●	Naples (IT)	●	●	Zürich (CH)	●	●
Edinburgh (UK)	●	●	Newcastle	●	●			
Florence (IT)	●	●	Oporto (PT)	●	●			
Gdansk (PL)	●	●	Palermo (IT)	●	●			
Geneva (CH)	●	●	Paris (FR)	●	●			

Unsuitable ●  
 Uncertain ●  
 Suitable ●

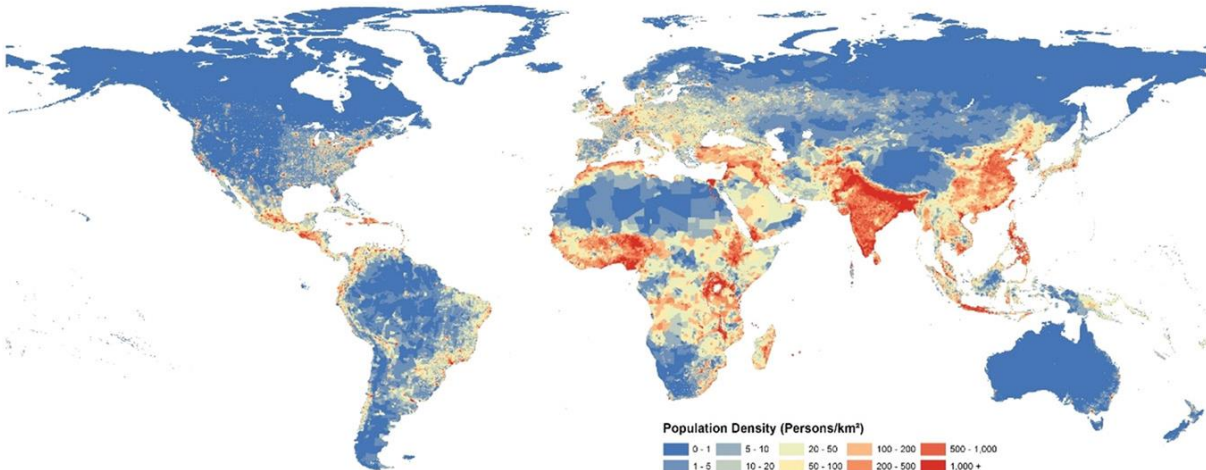
- Cities located in northern Europe expected to undergo the most severe changes (from unsuitable to suitable)  
*Arhus, Copenhagen, Gothenburg, Stavanger*
- Cities of central Europe, Great Britain and Ireland are expected to become suitable (from uncertain today)  
*Berlin, Dublin, Geneva, London, Prague, Vienna*
- Uncertainty remains in the future for cities such as:  
*Edinburgh, Madrid, Munich, Warsaw*

### 3. Urban population exposed in 2050

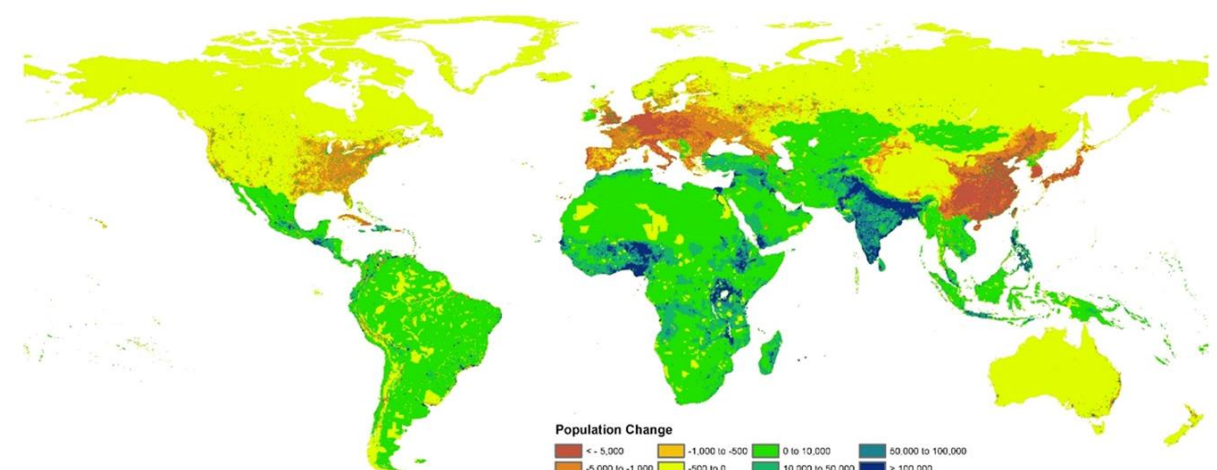
#### Shared Socioeconomic Pathways (SSP) - Future pathways of societal development

- **5 alternative outcomes** for trends in demographics, economics, technological development, lifestyles, governance...
- Provide **quantitative projections of key elements**, including national level population growth, educational composition, urbanization, and economic growth.

Population density



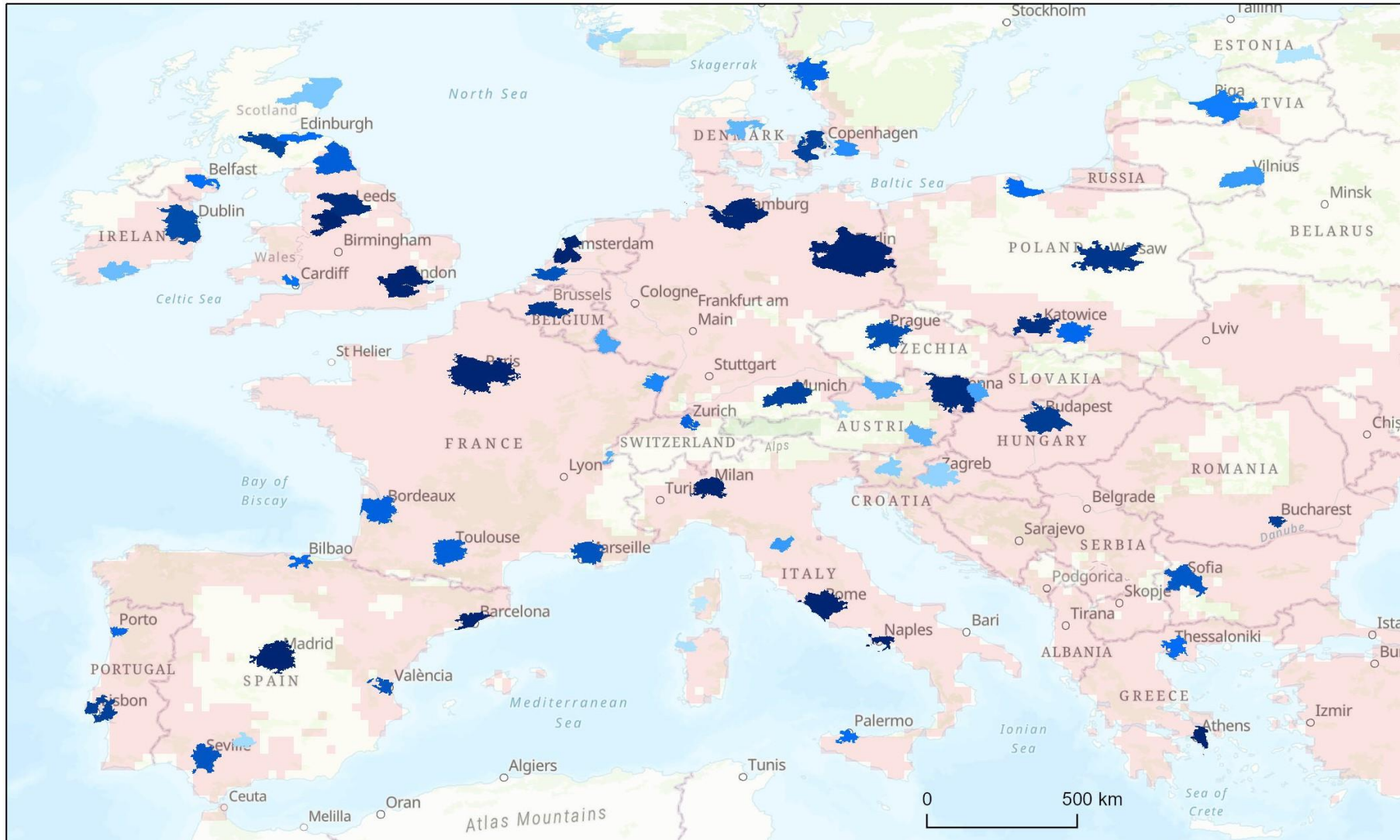
Population change



**SSP3** - intermediate level of growth regarding demographics, economics, technology, governance (Gao, 2020; Jones & O'Neill, 2016).

Data from **Global Population Grid (1 km)** - <https://sedac.ciesin.columbia.edu/data/set/popdynamics-1-km-downscaled-pop-base-year-projection-ssp-2000-2100-rev01>

### 3. Urban population exposed in 2050



Suitable cities present  
~60 million

Suitable cities future (2050)  
~110 million

- Paris - 14 million
- London – 12 million
- Barcelona – 4.8 million
- Berlin – 4.7 million
- Milan – 4.6 million
- Valencia – 1.7 million
- Porto – 1.2 million

**2020 – 60 million**

**2050 – 110 million**

In Europe, the increase in exposure is caused by changes in environmental suitability, it's not due to population growth.

## ***What can we do to protect our cities and urban dwellers?***

- ✓ Surveillance and monitoring of the species (ports, ground transport, airports)
- ✓ Integrate vector-borne diseases in public health policies
- ✓ Improve community awareness for potential exposure
- ✓ Adapt urban areas (reshape water reservoirs, control microhabitats, larvae control)

Gracias!  
*Thank you!*

